APPENDIX D: VALUE ENGINEERING FOR HIGHWAYS STUDY WORKBOOK

The figures originally included in this appendix are available as hard copies only. These figures may be viewed in copies of the document at the following locations:

Provo City Library
425 West Center Street
Provo, UT 84601
801.852.6650

Orem Public Library
58 North State Street
Orem, UT 84057
801.229.7050

Wasatch County Library
188 South Main Street
Heber City, UT 84032
435.654.1511

Utah Department of Transportation
Region 3 Office
658 North 1500 West
Orem, UT 84057
801.227.8000

Provo Canyon

U.S. 189

Wildwood to Deer Creek State Park

VALUE ENGINEERING FOR HIGHWAYS
STUDY WORKBOOK

Project Number
NH-0189(5)14

May 1994 - October 1994

Table of Contents

Note:
This document is a summary of the Value Engineering Team's efforts. It is not a transcript of the meetings that were held. Instead it contains a summation of the discussions from these meetings. Additional information is available from the document assembled by Centennial Engineering during the course of the study and titled Provo Canyon, U.S. 189, Wildwood to Deer Creek State Park, Alignment Summary Report.

Introduction

Value Engineering (VE) is a tool whose strength lies in its ability to delineate design alternatives in a manner that show their strengths and weaknesses. To accomplish this task VE uses a defined process to gather, sort, and quantify pertinent data. The following is an overview of the standard eight phases of this process:

Selection - Criteria is established that determines which projects VE is suitable for.
Investigation - This task involves gathering of data that allows the VE team to speculate on and evaluate the portions of the design that will result in providing the most valuable overall product.
Speculation - The VE team utilizes creativity techniques to list every possible alternative. All judgment is withheld at this point and no alternatives are dismissed. Frequently, further investigation is required after this process takes place to further define alternatives that were not foreseen prior to this step.
Evaluation - At this point all of the alternatives that were forwarded in the speculation phase are evaluated. If an alternative contains a critical flaw, it is discarded. The data gathered in the investigation phase is used to quantify items that are significant to each remaining alternative. The overall score for each alternative is then calculated to determine the alternatives that are advanced.
Development - The selected alternatives are then developed to a point that they can be presented to the UDOT Senior Staff members for concurrence.
Presentation - The VE staff present the alternative to the members of the UDOT Senior Staff. This may also involve presentations to the public in informal presentations and/or formal public hearings.
Implementation - The alternatives are prepared as part of a construction package. The construction of the alternative is completed and data gathered to allow an audit of the effectiveness of the total process.
Audit - UDOT's VE staff will assemble data on the process and provide a final audit of the value of the alternatives selected from this process.

The **selection** and initial **investigation** phases occurred prior to the June 1, 1994 meeting. This project met the **selection** criteria based on the estimated $50 million construction cost. Data gathering began with the **investigation** of several alignment alternatives. These alternatives were presented at the first **speculation** meeting held June 1, 1994.

Value Engineering Team Members

A VE team with experts in the areas of roadway design, geotechnical engineering, highway structures, environmental analysis, hydraulics, and safety issues was selected. The team members were:
Randy Park P.E. - UDOT Region 3 Project Manager
Ahmad Jabar P.E. - UDOT Region 3 Assistant Director
Philip Huff - UDOT Region 3 Design Engineer
Carlos Braceras P.E. - UDOT Value Engineer
Keith Brown P.E. - UDOT Value Engineering
James Golden P.E. - UDOT Structures
David Berg P.E. - UDOT Environmental Engineer
David Nazare P.E. - UDOT Hydraulics Engineer
Ed Keane P.E. - UDOT Geotechnical Engineer
Don Kilmore - FHWA
Roy Nelson - FHWA
Hal Clyde - Utah Highway Commissioner
Michael Robertson P.E. - Centennial Engineering Project Manager
Ted Ritschard P.E. - Centennial Engineering Project Engineer
Lance DeBernardi - Centennial Engineering Roadway Designer

During the initial **investigation** phase, Centennial Engineering with the help of Parsons Brinckerhoff Quade and Douglas compiled data as it pertained to the roadway design including geotechnical considerations. BIO/WEST Inc. provided a compilation of the data associated with environmental aspects of the alternatives.

This information was presented to the VE team at the June 1, 1994 meeting. An overview of that meeting is contained in the following section.

Speculation Phase

The first meeting of the VE team occurred on June 1, 1994. At the meeting, the overall function of the project was discussed. Improving the safety and mobility of the highway facility were defined as the basic functions. Both criteria also meet the purpose and need as defined by the 1989 Supplemental Environmental Impact Statement (SEIS) on page 1-1. Secondary functions addressing the preservation of the environment, solutions to structural problems, and improved access were listed.

The purpose of this meeting was to provide the design team with alignment alternatives for an in-depth study. Centennial Engineering representatives presented an overview of the alignment alternatives that had been reviewed to date.

To make the process of **speculation** and **evaluation** as simple as possible the alignment was broken into four sections. The physical boundaries of these sections were stated as:

Section 1 - Wildwood to the Beginning of Horseshoe Bend
Section 2 - Horseshoe Bend to the Heber Valley Historic Railroad Overpass
Section 3 - Heber Valley Historic Railroad Overpass to the First Entrance of the Deer Creek State Park
Section 4 - First Entrance of the Deer Creek State Park to the Public Entrance of the Deer Creek State Park

These same sections were used throughout the meetings to define alternatives per section. The VE team then began a brainstorming session in which all alignment alternatives were advanced regardless of feasibility or value. A brief description of each alternative is listed below by section and are as follows:

Meeting held June 1, 1994 - Brainstorming

Section 1 - Wildwood to the Beginning of Horseshoe Bend

1. SEIS - The alignment found in the Supplemental Environmental Impact Statement (SEIS) was very conceptual and contained only pictorial information for the horizontal layout. This was modeled as closely as possible and used as a baseline of impacts to compare all of the alignment alternatives.
2. Adjusted SEIS - Due to the encroachment of the modeled SEIS alignment on the Provo River, adjustments were made to move it further into the hillside. This resulted in larger cut slopes than shown in the SEIS. However, all encroachments into the Provo River were eliminated.
3. Split - A horizontal alignment similar to the Adjusted SEIS was employed. The up and down canyon traffic lanes were to be horizontally and vertically separated to more closely follow the terrain. The intention was to reduce the cut heights, cost, and visual impacts.
4. East Side of River - This alignment would cross to the east side of the Provo River prior to station 18+400 and remain on that side through this section. The intent was that this alignment would not require large cut slopes on the west side of the river.
5. Put the Entire Roadway on a Structure - If the roadway could be placed on a structure, the impacts to the river may be reduced and the cut heights on the west side of the alignment may be reduced or eliminated.
6. Tunnels - Two tunnels were to be placed at two large cut sections at Sta. 18+600 & 19+000. This may have reduced the visual impacts and the amount of excavation while remaining away from the Provo River.
7. Entire Roadway on a High Fill (Elevated) - This was similar to alignment number 5 except that a large fill section would take the place of the structure.
8. Split Alignment, with Tunnels on East Side of the Provo River - This was a combination of alignment numbers 3, 4 and 6. The roadway would be pushed farther into the hillside to allow tunnels to be constructed into the eastern slope of the canyon. The intent was to reduce visual impacts.

9. Roadway on Structures on the East Side of the Provo River - As above, this was a combination of alignment numbers 4 and 5. Again the intent was reduce the visual impact of large cuts on the western slope of the canyon.
10. Use a Cantilever Structure Over the Provo River - This structure was to allow the roadway to hang over the river avoiding direct impact to the river and reducing cuts on the west side of the highway.
11. Stack the Roadways - This idea placed the down canyon traffic lanes on top of the up canyon lanes using a cantilever structure. The result was to be a narrower section that would have less impact to the Provo River and reduce hillside cut slope heights.
12. Reduce Typical Section and/or Reduce Design Speed - This alignment option was intended to narrow the overall width of the section or make use of tighter curves. The result would be to allow the roadway to follow the existing topography more closely. The roadway would then be less likely to impact the Provo River and may reduce the cut heights on the west side slopes.
13. Relocate the Provo River - If it was possible to relocate the river farther to the east, the roadway could then be moved away from the western hill slopes. This would reduce overall excavation.

Section 2 - Horseshoe Bend to the Heber Valley Historic Railroad Overpass

1. SEIS - The alignment approximates the existing highway, horizontally and vertically until Horseshoe Bend where it departs and crosses the railroad and river with a series of bridges. After the Horseshoe Bend area, the alignment follows the existing highway. Less area would be disturbed by building bridges to cross the river. This was used as a baseline to compare all of the alignment alternatives.
2. Adjusted SEIS, Lower Variation - The alignment follows the existing roadway through the entire section. Around Horseshoe Bend, retaining walls would be used to prevent river and railroad encroachment. No bridges would be necessary.
3. Adjusted SEIS, Upper Variation - The alignment would depart from the existing roadway on the down canyon side of Horseshoe Bend and travel up through the saddle and cross in front of Canyon Meadows. Bridges would not be built on the slide, and the cuts would be smaller than those modeled using the SEIS option.
4. Combined (up canyon traffic-lower variation, down canyon traffic-upper variation) - Prior to Horseshoe Bend, the alignments begin to separate horizontally and vertically. The up canyon lanes follow the existing roadway and the down canyon lanes travel up through the saddle, crossing in front of Canyon Meadows and rejoining the existing roadway near the Heber Creeper Railroad overpass. This option would not require bridges to be built on the slide, and the visual impact to Canyon Meadows would be reduced due to the direction and half the number of traffic lanes traveling through the area.
5. Split Upper Variation - This alignment is similar to number 3 (Upper Variation alignment), but the up and down canyon traffic lanes would have independent horizontal and vertical alignments. Bridges would not be built on the slide, and the visual impact to Canyon Meadows would be reduced with a lower vertical profile for the up canyon traffic lanes..
6. Split Lower Variation - This alignment is similar to number 2 (Lower Variation alignment) with the alignment following the existing roadway through the entire section. The up and down canyon lanes would have independent horizontal and vertical alignments. This would reduce excavation volumes, and reduce the height of the toe wall.
7. Adjusted SEIS, Lower Variation with Cantilever - This alignment is similar to number 2 (Lower Variation alignment). At Horseshoe Bend, a cantilever section would be used to extend the roadway out and over the railroad. This would prevent railroad and river encroachment, have smaller cuts, and reduce or eliminate some retaining wall.
8. Roadway on Structures on the East Side of the Provo River - The alignment would be built on a structure staying on the east side of the river. The intent was to reduce the impacts to the river and reduce the visual impact of large cuts on the western slope of the canyon.
9. SEIS with a Maintainable Abutment - This alignment is number 1 (SEIS) with abutments that could be maintained as the slide area moves.
10. Upper Variation with a Structure - This alignment is similar to number 3 (Upper Variation alignment), but uses a bridge to span from the down canyon side of Horseshoe Bend to

the saddle. The intent was to reduce the amount of retaining walls and large cut slope heights.

11. Tunnel Under Canyon Meadows - The alignment would tunnel under the Canyon Meadows Area making any relocations unnecessary as well as reducing the visual impacts of the highway.
12. Piggyback Cars with Train - Ferry the cars up/down canyon without having the build the roadway.
13. SEIS Alignment "A" - This alignment would bypass the main slide area to the west and go around the backside of the Canyon Meadows development. The intent was to avoid the slide area, and stay away from the river.
14. Single Structure at Horseshoe Bend and Tunnel Through Knob - The alignment would follow the existing roadway until Horseshoe Bend. At Horseshoe Bend, a 4-lane bridge would be built to cross the railroad and river. After the bridge, a tunnel would be built through the knob to avoid large cuts. This would be a more direct alignment.
15. Stack the Structures - This alignment is similar to number 1 (SEIS). The up canyon and down canyon lanes would be built one on top of the other. The intent was to elevate the up canyon and down canyon traffic lanes with a separate set of structures to lessen the impact on the canyon.
16. Stack the Roadways - The up canyon traffic lanes would follow a similar alignment to number 1 (SEIS) with the down canyon traffic lanes elevated above the up canyon using a cantilever structure. The intent was to narrow the roadway section resulting in less impact to the Provo River and a reduction of cut slope heights to the hillside.
17. Entire Roadway on a High Fill - This alignment would follow option number 2 (Lower Variation). The roadway would be placed on a large fill section with east side retaining walls. The impacts to the river and the cut heights on the west side of the alignment may be reduced.
18. Entire Roadway on a Structure - This alignment would follow option number 2 (Lower Variation) with the 4 traffic lanes placed on a continuous structure. The impacts to the river and the cut heights on the west side of the alignment may be reduced.
19. Reduce Design Speed at Horseshoe Bend - This alignment option is similar to number 2 (Lower Variation). The intent of reducing the design speed was to make use of smaller radius curves at Horseshoe Bend to limit railroad and river encroachment.

Section 3 - Heber Valley Historic Railroad Overpass to the First Entrance of the Deer Creek State Park

1. SEIS - The alignment approximates the existing highway, horizontally and vertically until it crosses over the Heber Creeper Railroad. The roadway crosses the river and comes back to existing ground above the power plant. A snow shed structure is used to pass the avalanche over roadway as it crosses the first of two avalanche paths. A third bridge crosses a portion of Deer Creek Reservoir allowing the second avalanche to pass under the bridge. The alignment rejoins the existing highway near the first entrance to Deer Creek State Park. This was used as a baseline to compare all of the alignment alternatives.
2. Adjusted SEIS - This alignment is the same as number 1 (SEIS), but this alignment has been vertically adjusted to clear the top of the dam. This resulted in a longer bridge, but the snow shed structure would not be necessary and the cut heights might be reduced.
3. Split Alignment at the Dam - This alignment was separated horizontally and vertically using independent horizontal and vertical alignments for the up and down canyon traffic lanes. The alignment uses a structure to span the Heber Creeper Railroad and the first avalanche path coming to ground near the south abutment of the Dam. A set of structures pass the up and down canyon traffic lanes over the second avalanche path and then rejoins the existing highway near the first entrance to the Deer Creek State Park. The intent was to reduce the amount of cut on the east hillside of the reservoir.
4. Buttress Fill - This alignment option departs from the existing highway near the power substation and rises to pass over the Heber Creeper Railroad near the existing Heber Creeper overpass. The horizontal alignment traverses across the face of the dam with the vertical profile rising so that the entire section is in fill. The intent was to avoid the long bridge, the first avalanche path, and provide a waste site for excess material.

5. North Side of Reservoir, Structure Across Reservoir - This alignment would leave the existing roadway near the north side of the dam and travel along the north side of the reservoir. The roadway would cross the reservoir on a structure and rejoin the existing roadway near the first entrance to Deer Creek State Park. The intent was to avoid the avalanche paths and the large cuts.
6. Entire Roadway on North Side of the Reservoir - This alignment would leave the existing roadway near the north side of the dam and travel along the north side of the reservoir. The roadway would pass near the communities of Charleston and Heber and tie into the improved U.S. Highway 40. The intents were to avoid using a structure and avoid the avalanche paths and large cuts.
7. Replace Large Structure with Fill - This alignment follows number 1 (SEIS), but the roadway would be built on a large fill section instead of a bridge to pass over the Provo River. The intent was to reduce the length or eliminate the structure.
8. Tunnels Near Dam - Tunnels were to be placed from Station 23+000 to Station 25+200. The tunnels would begin before the first avalanche path and end at the first entrance to Deer Creek State Park. Large cuts and the avalanche paths would be avoided.
9. Cantilever Sections at Dam - This alignment follows the existing roadway but uses a cantilever section widened to 4-lanes to cross the Dam and overhang the reservoir enroute to the first entrance to Deer Creek State Park. This would avoid the large cuts along the south side of the reservoir.
10. Full South Side Alignment - This alignment would be a result of staying on the east side of the Provo River in Sections 1 and 2. The options for Section 3 would be numbers 1, 2, 3, 4, 7, 9 for the cut options and number 8 for the tunnel option.
11. Maximize Vertical Grade - As the alignment option approaches the dam, a maximum vertical grade would be used to place the roadway as high as possible above the reservoir so the cuts on the hillside are minimized.
12. Buttress Fill and Stay Above Homes - This alignment option was similar to number 4 (Buttress Fill). However, the alignment would pass north of the homes in the Weeks Bench Area. The intent was to not impact the dwellings.
13. Pull SEIS Toward Reservoir, Use Structures Over Reservoir - The alignment is similar to number 1 (SEIS), but would be pulled away from the hillside and shifted toward the reservoir. The intent was to avoid the large cuts on the hillside by placing the 4-lane roadway on structures.
14. Floating Bridge - This alignment option is similar to number 5 (North Side of Reservoir, Structure Across Reservoir), but would replace the overhead bridge with a floating bridge. The intent was to improve aesthetics, and avoid the avalanche paths and large cuts.

Section 4 - First Entrance of the Deer Creek State Park to the Public Entrance of the Deer Creek State Park

1. SEIS - This alignment approximates the existing highway horizontally and vertically as forwarded in the 1989 SEIS Document.

Meeting held August 31 and September 1, 1994 - Brainstorming

At the August 31 and September 1, 1994 meeting, the VE team determined that additional information was needed in Section 2 before a recommended alignment could be chosen. The VE team then began a brainstorming session and the possible alignment options follow:

Section 2 - Horseshoe Bend to the Heber Valley Historic Railroad Overpass

1. SEIS Alignment “A” - This alignment would bypass the main slide area to the west and go around the backside of the Canyon Meadows development. The intent was to avoid the slide area and structures as well as stay away from the river
2. Up Canyon (SEIS), Down Canyon (Upper Variation) - The up canyon traffic lanes would follow the SEIS alignment using bridges to cross over the river. The down canyon traffic lanes would follow the Upper Variation alignment. The intent was to reduce bridge width for the up canyon traffic lanes and some tie-back retaining walls might be eliminated.

3. Lower Variation, Relocate Railroad - The roadway would follow the Lower Variation alignment option using the additional width from the relocation of the railroad. The railroad would be relocated to the east side of the river and approximate the SEIS alignment. The railroad would bridge the river, tunnel through the knob, and return to the original railroad alignment via a bridge. The intent was to reduce the impacts and cost because the railroad bridge would be narrower than the roadway bridge. Some retaining wall heights and locations may be reduced or eliminated.
4. Lower Variation, Relocate River - The roadway would follow the Lower Variation alignment option using the additional width from the relocation of the railroad and river. The intent was to relocate the river farther to the east so the roadway could then be shifted away from the western hill slopes in an effort to reduce overall excavation, retaining wall heights and locations.
5. East Side of the Provo River - This alignment would cross to the east side of the Provo River and remain on that side. The intent was that this alignment would not require large cut slopes on the west side of the river.
6. Up Canyon (Existing Alignment), Down Canyon (Upper Variation) - The up canyon traffic lanes would follow the existing roadway, and the down canyon traffic lanes would follow the Upper Variation alignment. No structures would be necessary, and the cut heights could be reduced.
7. a. Tangent Bridge - This alignment would follow the SEIS alignment but would be adjusted so the bridges would be on tangent sections. The intent with tangent bridge sections was to reduce the bridge span, amount of wall, and lessen the impact to Canyon Meadows.

   b. Up canyon (Tangent Bridge), Down Canyon (Upper Variation) - The up canyon traffic lanes would follow the Tangent Bridge alignment and the down canyon traffic lanes would follow the Upper Variation alignment. The intent was to narrow the bridge for the up canyon traffic lanes, and move the down canyon traffic lanes away from the river.
8. Up canyon (Tangent Bridge), Down Canyon (Existing Alignment) - The up canyon traffic lanes would follow the Tangent Bridge alignment and the down canyon traffic lanes would follow the existing roadway. The intent was to narrow the bridge for the up canyon traffic lanes, lessen the impact to Canyon Meadows, reduce cut slope heights, and amount of retaining wall needed.
9. Enclose Railroad and Build Roadway Over Railroad - This alignment would follow the Lower Variation alignment but the railroad would be enclosed so the 4-lane roadway could be built over the railroad. The intent was to prevent river encroachment, eliminate bridges, reduce cut slope heights, and retaining wall heights.
10. Upper Variation - This alignment was an adjusted version of the Upper Variation. The intent was to reduce tie-back and retaining wall heights by making small horizontal and vertical modifications.

Evaluation Phase

The SEIS Alignment was used as a comparative baseline against which all alignment alternatives were evaluated. Each alternative was compared to the SEIS (unless otherwise stated), and the advantages and disadvantages as a comparison are listed below. Those alignment alternatives that were not feasible for reasons of: safety, mobility, constructability, being outside the scope of the SEIS, cost, environmental, geotechnical and engineering design were not forwarded for further study.

Meeting held June 1, 1994 - Advantages/Disadvantages Roadway Sections 1, 2, 3 and 4

Section 1 - Wildwood to the Beginning of Horseshoe Bend

1. SEIS Alignment

Advantages	Disadvantages
Approved Alignment in SEIS Document	Roadway fills slopes encroach on river
Smaller cut heights	Retaining wall locations encroach on river
Lower excavation costs	Inconsistent language in SEIS Document
	Difficult to construct

Idea will be forwarded

2. Adjusted SEIS Alignment

Advantages	Disadvantages
Stays out of the river	Larger cut heights
Follows the topography better	Increase in vegetation loss
Constructable	Larger retaining wall heights
	More excavation

Idea will be forwarded

3. Split Alignment

Advantages	Disadvantages
Stays out of the river	River access more restricted
Smaller retaining wall heights	Median retaining wall required
Easier traffic control	Difficult snow removal
Better aesthetics	Increased maintenance cost
Less excavation	
Smaller cut heights	
Constructable	

Idea will be forwarded

4. East Side of River

Advantages	Disadvantages
Easier traffic control Constructable	*Significantly differs from conceptual alignment in SEIS Document Increased ice and snow problems due to east facing slope Increased impact to the Heber Creeper Added river crossing Conflict with Salt Lake City Metro Water District aqueduct No reduction in cut heights Possible wetland impact Affect floodplain New highway facility in untouched location Abandon existing alignment Difficulty in maintaining west side access

Idea will **not** be forwarded

5. Put the Entire Roadway on a Structure

Advantages	Disadvantages
Less excavation Smaller cut heights	*Significantly differs from conceptual alignment in SEIS Document *Very high cost High maintenance cost Future rehabilitation Difficult traffic control Vertical alignment tie-in problem Icing problems

Idea will **not** be forwarded

6. Tunnels (18+600 to 19+000)

Advantages	Disadvantages
No ice problem Reduce cut heights Better aesthetics Less excavation	*Very high cost of tunnel, portal structures and retaining walls Public sentiment on past projects resulted in numerous redesign efforts

Idea will **not** be forwarded

7. Entire Road on a High Fill (Elevated)

Advantages	Disadvantages
Material site on project Small or no cut heights	Retaining walls required along entire alignment Vertical alignment tie-in problem Difficult constructability and traffic control

Idea will be forwarded

*Denotes fatal flaw and will not be considered further.

8. Split Alignment with Tunnels on East Side of the Provo River

Advantages	Disadvantages
Stays out of the river Easier traffic control Smaller retaining wall heights Less excavation No ice problem Better aesthetics	*Significantly differs from conceptual alignment in SEIS Document *Very high cost River access restricted Median retaining wall required Difficult snow removal Impact to the Heber Creeper Abandon existing alignment *Conflict with Salt Lake City Metro Water District aqueduct Wetland and floodplain impacts New highway facility in untouched location Negative public sentiment associated with additional river crossings on past projects resulted in numerous redesign efforts

Idea will **not** be forwarded

9. Roadway on Structures on the East Side of the Provo River

Advantages	Disadvantages
Small or no cut heights Easier traffic control Less excavation	*Significantly differs from conceptual alignment in SEIS Document *Very high cost Abandon existing alignment High maintenance and structure rehabilitation costs Ice problems New highway facility in untouched location Impact to the Heber Creeper *Conflict with Salt Lake City Metro Water District aqueduct *Negative public sentiment associated with additional river crossings on past projects resulted in numerous redesign efforts River access restricted

Idea will **not** be forwarded

10. Use a Cantilever Section Over the Provo River

Advantages	Disadvantages
Small or no cut heights Less excavation	*Very high cost Ice problems Shade riparian area High maintenance and structure rehabilitation costs Difficult traffic control Higher design costs *Difficult design

Idea will **not** be forwarded

*Denotes fatal flaw and will not be considered further.

11. Stack the Roadways

Advantages	Disadvantages
Small or no cut heights Less excavation	*Very high cost Ice problems Shade riparian area *High maintenance and structure rehabilitation costs Difficult traffic control Higher design costs *Difficult design

Idea will **not** be forwarded

12. Reduce Typical Section and/or Reduce Design Speed

Advantages	Disadvantages
Smaller cut heights Less excavation	**Significantly differs from conceptual alignment in SEIS Document Decrease safety Requires a design exception **Level of service might not be acceptable past design year Reduce mobility Doesn't meet basic function as defined by VE Team

Idea will be forwarded

13. Relocate the Provo River

Advantages	Disadvantages
Build a safer roadway facility Freedom for alignment location	*The SEIS Document forbade any reach of the Provo River for relocation

Idea will **not** be forwarded

<u>Section 2 - Horseshoe Bend to the Heber Valley Historic Railroad Overpass</u>

1. SEIS Alignment

Advantages	Disadvantages
Meets basic function as defined by VE Team Disturbs less new area by utilizing the existing roadway prism where ever possible	Bridges and retaining walls located on slide Cross river twice High bridge maintenance and rehabilitation costs Traffic control problem near knob Retaining walls may be needed on both fill and cut side Removal of some homes Alignment crosses slide Future highway maintenance and rehabilitation costs River and riparian impacts

Idea will be forwarded

*Denotes fatal flaw and will not be considered further.
**UDOT instructed Centennial Engineering to conduct a traffic and speed study to determine if reducing typical section and/or design speed was feasible. The results are in the Alignment Summary Report.

2. Adjusted SEIS, Lower Variation Alignment

Advantages	Disadvantages
No bridge structures on the slide No bridge costs Stays out of the river	Traffic control problem Larger cut heights More excavation Alignment crosses slide Large cut north of Horseshoe Bend Retaining walls may be needed on both fill and cut side Retaining walls on slide Increase fill on existing road in Horseshoe Bend Removal of some homes

Idea will be forwarded

3. Adjusted SEIS, Upper Variation Alignment

Advantages	Disadvantages
No structures (bridge/wall) on slide Better fishing access Easier traffic control Lower cost Less cuts and excavation-easier to mitigate and revegetate Safer highway geometrics from saddle to dam Less geotechnical risk of losing retaining walls/structures No removal of homes	Large cut north of Horseshoe Bend Canyon Meadows impact Wetland impact Loss of wildlife winter range Steep grade from Horseshoe Bend to saddle Unknown geotechnical and ground water conditions in Canyon Meadows

Idea will be forwarded

4. Combined (2 lanes each-Lower Variation and Upper Variation)

Advantages	Disadvantages
Less excavation Less visual impact to Canyon Meadows Lower cost No bridge structures on the slide Easier traffic control	*High cost Removal of some homes Homes in median area Difficult to access Canyon Meadows (this alignment option was not forwarded because it did not provide anything that the Upper or Lower Variation would not and it had all of the negative impacts of both)

Idea will **not** be forwarded

5. Split Upper Variation

Advantages	Disadvantages
No headlight problem to Canyon Meadows No structures (bridge/wall) on slide Better fishing access Easier traffic control Lower cost Less cuts and excavation-easier to mitigate and revegetate Safer highway geometrics from saddle to dam Less geotechnical risk of losing walls/structures No removal of homes Less visual impact	More excavation Large cut north of Horseshoe Bend Canyon Meadows impact Wetland impact Loss of wildlife winter range Steep grade from Horseshoe Bend to saddle Unknown geotechnical and ground water conditions in Canyon Meadows

Idea will be forwarded

*Denotes fatal flaw and will not be considered further.

6. Split Lower Variation

Advantages	Disadvantages
Less excavation Reduced toe wall height	Median retaining wall required Difficult to access Canyon Meadows *Difficult constructability and traffic control Alignment crosses slide Large cut north of Horseshoe Bend Retaining walls may be needed on both fill and cut side *Retaining walls on slide *Increase fill on existing road in Horseshoe Bend Removal of some homes

Idea will **not** be forwarded

7. Adjusted SEIS, Lower with Cantilever Section at Horseshoe Bend

Advantages	Disadvantages
Small or no cut heights Less excavation	*Very high cost Icing problems Shade riparian areas *High structure maintenance and rehabilitation costs Difficult traffic control High design costs *Difficult design

Idea will **not** be forwarded

8. Roadway on Structures on the East Side of the Provo River

Advantages	Disadvantages
Small or no cut heights Easier traffic control Less excavation	*Significantly differs from conceptual alignment in SEIS Document *Very high cost Abandon existing alignment High maintenance and structure rehabilitation costs Ice problems New highway facility in untouched location Impact to the Heber Creeper *Conflict with Salt Lake City Metro Water District aqueduct *Negative public sentiment associated with additional river crossings on past projects resulted in numerous redesign efforts River access restricted

Idea will **not** be forwarded

*Denotes fatal flaw and will not be considered further.

9. SEIS Alignment with Maintainable Abutment

Advantages	Disadvantages
Meets basic function as defined by VE Team Disturbs less new area by utilizing the existing roadway prism where ever possible	May not be possible to build Need additional geotechnical information on slide Bridges and retaining walls located on slide Cross river twice *High initial cost of bridges to accommodate displacement *High bridge maintenance and rehabilitation costs Traffic control problem near knob Retaining walls may be needed on both fill and cut side Removal of some homes Alignment crosses slide River and riparian impacts

Idea will **not** be forwarded

10. Upper Variation with a Structure

Advantages	Disadvantages
Eliminates the large cut north of Horseshoe Bend Safer highway geometrics from saddle to dam Better fishing access Easier traffic control Less cuts and excavation-easier to mitigate and revegetate Less geotechnical risk of losing walls/structures No removal of homes	*Structure abutment on slide Large cut north of Horseshoe Bend Canyon Meadows impact Steep grade from Horseshoe Bend to saddle Loss of wildlife winter range Wetland impact *High maintenance and structure rehabilitation costs Unknown geotechnical and ground water conditions in Canyon Meadows

Idea will **not** be forwarded

11. Tunnel Under Canyon Meadows

Advantages	Disadvantages
Aesthetics for Canyon Meadows	*Very high cost *Structure on slide (Tunnel)

Idea will **not** be forwarded

12. Piggyback Cars with Train

Advantages	Disadvantages
No built option	*Does not fulfill the purpose and need of the SEIS Document *Does not meet the basic function as defined by the VE Team

Idea will **not** be forwarded

*Denotes fatal flaw and will not be considered further.

13. SEIS Alignment "A"

Advantages	Disadvantages
Out of the slide area Stays away from the river Easier traffic control	Difficult constructability *New highway facility in untouched location Canyon Meadows impact Loss of wildlife winter range Roadway not a direct route River access restricted Time frame for design *Continuous 5% grades Length of alignment 2 miles longer *Increased user costs associated with increased length

Idea will **not** be forwarded

14. Single Structure at Horseshoe Bend and Tunnel Through Knob

Advantages	Disadvantages
Safer highway geometrics	*Bridge and tunnel structures on slide *High cost of bridge and tunnel *High maintenance and structure rehabilitation costs

Idea will **not** be forwarded

15. Stack the Structures

Advantages	Disadvantages
Small or no cut heights Less excavation	*Very high cost Ice problems Shade riparian area *High maintenance and structure rehabilitation costs *Difficult constructability and traffic control Higher design costs *Difficult design

Idea will **not** be forwarded

16. Stack the Roadway

Advantages	Disadvantages
Small or no cut heights Less excavation	*Very high cost Ice problems Shade riparian area *High maintenance and structure rehabilitation costs *Difficult constructability and traffic control Higher design costs *Difficult design

Idea will **not** be forwarded

17. Entire Roadway on a High Fill

Advantages	Disadvantages
Material site on project Small or no cut heights	Retaining walls required along entire alignment Vertical alignment tie-in problem *Difficult constructability and traffic control

Idea will **not** be forwarded

*Denotes fatal flaw and will not be considered further.

18. Entire Roadway on a Structure

Advantages	Disadvantages
Small or no cut heights Less excavation	*Very high cost Ice problems Shade riparian area *High maintenance and structure rehabilitation costs *Difficult constructability and traffic control Higher design costs *Difficult design Vertical alignment tie-in problem Difficulty in maintaining existing access

Idea will **not** be forwarded

19. Reduce Design Speed at Horseshoe Bend

Advantages	Disadvantages
Small or no cut heights Less excavation	**Significantly differs from conceptual alignment in SEIS Document Decrease safety Requires a design exception **Level of service might not be acceptable past design year Reduce mobility Doesn't meet basic function as defined by VE Team

Idea will be forwarded

<u>Section 3 - Heber Valley Historic Railroad Overpass to the First Entrance of the Deer Creek State Park</u>

1. SEIS Alignment

Advantages	Disadvantages
Short bridge to dam Safer highway geometrics	*Vertical profile of roadway is below the crest elevation of dam Need snow shed Abutment on engineered fill Second structure may be too low to pass avalanche Bridge piers in water by reservoir intake Icing on bridges Large cut heights Difficult constructability and traffic control Piers might have 4F land impact

Idea will be forwarded

*Denotes fatal flaw and will not be considered further.
**UDOT instructed Centennial Engineering to conduct a traffic and speed study to determine if reducing design speed was feasible. The results are in the Alignment Summary Report.

2. Adjusted SEIS Alignment

Advantages	Disadvantages
Vertical profile of roadway is above the crest elevation of dam No snow sheds needed Avalanche path unaffected Less cut heights and excavation	Large structures Large cut heights *Icing on bridges Due to their location, the bridges will be in the shade Difficult constructability and traffic control *High cost of bridges

Idea will **not** be forwarded

3. Split Alignment at the Dam

Advantages	Disadvantages
Less excavation The first bridge length was less than Adjusted SEIS first bridge length Easier traffic control Avalanche path unaffected Second set of bridges costs less than Adjusted SEIS second bridge	Icing on bridges Large cuts heights Cost of 3 bridges High maintenance and structure rehabilitation costs Median retaining walls Due to their location, the bridges will be in the shade

Idea will be forwarded

4. Buttress Fill

Advantages	Disadvantages
Shortens bridges Less icing Material site on project Reduce cut height at corner of dam Avoids archeological areas Additional fill material placed at the toe of the dam will increase its structural integrity	May interfere with avalanche path Can the BOR work within the fast track schedule of this project? Aesthetics for homes at Weeks Bench due to close proximity of highway fill slopes Highway geometrics-steeper grade and sharper curves Affects access to powerplant and dam area Retaining walls required to channel avalanche and protect powerplant

Idea will be forwarded

5. North Side of Reservoir, Structure Across Reservoir

Advantages	Disadvantages
No interference with avalanche paths Easier traffic control Avoid large cut heights	*Significantly differs from conceptual alignment in SEIS Document Heber Creeper impacts The bridge length was less than Adjusted SEIS *4F land impacts *Very high cost Hazardous spill potential into reservoir New highway facility in untouched location

Idea will **not** be forwarded

*Denotes fatal flaw and will not be considered further.

6. Entire Roadway on North Side of the Reservoir

Advantages	Disadvantages
Less icing Avoid existing narrow roadway on south side of reservoir Avoid large cut heights along south side of reservoir	*Significantly differs from conceptual alignment in SEIS Document *4F land impacts Wetland impact Must maintain Wallsberg and other existing access roads Heber Creeper impacts New highway facility in untouched location *Very high cost

Idea will **not** be forwarded

7. Replace Large Structure with Fill

Advantages	Disadvantages
No structure or much smaller structure Material site on project	Fill in large area *River encroachment Archeology site impacts *Aesthetics of large fill

Idea will **not** be forwarded

8. Tunnels Near Dam

Advantages	Disadvantages
Avoid large cut heights Less excavation Avoid avalanche paths Aesthetics	*Very high cost High design cost *High maintenance and structure rehabilitation costs Ice problem in tunnel

Idea will **not** be forwarded

9. Cantilever Sections at Dam

Advantages	Disadvantages
Avoid large cut heights Less excavation Disturbs less new area by utilizing the existing roadway prism where ever possible	*Very high cost High design cost *High maintenance and structure rehabilitation costs BOR Approval of new roadway over dam may not be allowed *Limited roadway width available using 80 km/h design highway curves

Idea will **not** be forwarded

10. Full South Side Alignment

Advantages	Disadvantages
Safer highway geometrics	*Significantly differs from conceptual alignment in SEIS Document *New highway facility in untouched location *Conflict with Salt Lake City Metro Water District aqueduct Impact Heber Creeper Interference with avalanche paths Depends upon alignments in Sections 1 and 2

Idea will **not** be forwarded

*Denotes fatal flaw and will not be considered further.

11. Maximize Vertical Grade

Advantages	Disadvantages
Vertical profile of roadway is above the crest elevation of dam Smaller cut heights Less excavation	*High cost of bridges *Icing on bridges *Highway geometrics-steeper grade *Difficult constructability and traffic control Increased pier height for structure Vertical alignment tie-in problem

Idea will **not** be forwarded

12. Buttress Fill and Stay Above Homes

Advantages	Disadvantages
Highway geometrics better than Buttress Fill Shortens bridges Less icing Material site on project Reduce cut height at corner of dam Avoids archeological areas Additional fill material placed at the toe of the dam will increase its structural integrity	*May affect power substation Abandon existing alignment May interfere with avalanche path *New highway facility in untouched location Can the BOR work within the fast track schedule of this project? Aesthetics for homes at Weeks Bench due to close proximity of highway fill slopes *Affects access to camp ground, powerplant and dam area Retaining walls required to channel avalanche and protect powerplant

Idea will **not** be forwarded

13. Pull SEIS Toward Reservoir, Use Structures Over Reservoir

Advantages	Disadvantages
Smaller cut heights Less excavation Aesthetics Disturbs less new area by utilizing the existing roadway prism where ever possible	*Very high cost High design cost *Icing problems *High maintenance and structure rehabilitation costs Difficult constructability and traffic control

Idea will **not** be forwarded

14. Floating Bridge

Advantages	Disadvantages
No interference with avalanche paths Easier traffic control Avoid large cut heights Less excavation Aesthetics	*Significantly differs from conceptual alignment in SEIS Document Heber Creeper impacts *4F land impacts *Very high cost Hazardous spill potential into reservoir *New highway facility in untouched location *Reservoir fluctuation makes this unfeasible *Design costs *High maintenance and structure rehabilitation costs Behavior of bridge during winter months

Idea will **not** be forwarded

*Denotes fatal flaw and will not be considered further.

Section 4 - First Entrance of the Deer Creek State Park to the Public Entrance of the Deer Creek State Park

1. SEIS Alignment

Advantages	Disadvantages
Approved in SEIS Document Roadway footprint inside existing UDOT right of way	None

Idea will be forwarded

The original SEIS alternative was the best option, and the VE Team's brainstorming efforts did not result in any new or better ideas.

Meeting held June 1, 1994 - Alignments forwarded for Roadway Sections 1-4

Following the **selection**, **investigation**, **speculation**, and **evaluation** phases of the VE process, the VE Team forwarded the following alignment alternatives.

Section 1	SEIS Adjusted SEIS Elevated Split
Section 2	SEIS Lower Variation Upper Variation Split Upper Variation
Section 3	SEIS Buttress Fill Split - Section 3
Section 4	SEIS

Centennial Engineering presented an in-depth study entitled Provo Canyon U.S. 189 Wildwood to Deer Creek State Park, Value Engineering Evaluation Information Summary to the VE Team members for their review prior to August 31, 1994. On August 31 and September 1, 1994, the VE Team members reassembled with a single minded goal of choosing a preferred alignment in each of the four sections. This is part of the Value Engineering Study as well as another information packet entitled Additional Alignment Alternatives and Issues that was distributed by Centennial Engineering at the meeting. These sources will be referenced in this VE Study Summary Report.

Centennial Engineering investigated and summarized seven criteria concerning each alignment alternative in the four sections. The seven criteria used for the evaluation were:

- Cost
- Geotechnical/Maintenance
- Constructability
- Public Comment
- Geometrics/Safety
- Environmental
- Traffic Control

Meeting held August 31 and September 1, 1994 - Weighting and Criteria Roadway Sections 1-4

Criteria were selected that covered the most important aspects of the project. The VE team assigned a weighting factor to each of the criteria. This weighting factor reflected the team's perception of the importance of each individual criteria. The weighting ranged on a scale from 1 to 10 with 10 being the most critical.

Criteria	Weight	Discussion
Cost	10	The UDOT has a limited amount of funding with which to make the needed roadway improvements. It is UDOT's responsibility to make the best use of the public's limited highway fund. Five items were evaluated to determine an approximate cost for each of the alignment alternatives. These five items were earthwork, structures, pavement, right of way, and guardrail.
Geometrics/ Safety	8	The UDOT's basic function is to construct and maintain safe roads that meet the established design and safety standards.
Geotechnical/ Maintenance	5	This criteria is very important given the complex geology within the project limits. It was given a lower weighting factor due to incomplete data gathered from a geotechnical study/recovery program that was in the early stages of implementation
Environmental	7	It is UDOT's goal and part of their mission statement to minimize the environmental impacts associated with the design and construction of highway projects.
Constructability	3	This criteria is closely tied to the cost criteria, therefore, it was given a lower weighting.
Traffic Control	7	It is very important to UDOT that traffic be maintained through the canyon in as safe a manner as possible during the construction of the project.
Public Comment	4	Public comment is very important, but was given a lower weighting factor because efforts had been taken to incorporate the comments received from the April 27 and 28, 1994 public workshops into the alternatives that were discussed at this meeting.

The VE Team thoroughly discussed and rated, from 0 to 5, each of the seven criteria as they applied to each alignment alternative in the four sections. An Evaluation Matrix was generated to help quantify the results of the discussions. The rating scale used was:

5 = Superior
4 = Good
3 = Average
2 = Fair
1 = Poor
0 = Unacceptable

The rating was multiplied by the weighting to come up with a total number of points for each alignment alternative. The alignments were then ranked within each section based upon the total number of points. The alignment option ranked number 1 became the recommended alignment. In the final scoring of the alignment alternatives, the weighting did not affect the outcome of the alignment recommendations. As a result it was not necessary to use the weighting factors and only the raw scores will be shown throughout the remainder of the report

Section 1 Discussion

Cost The alignment alternatives were rated solely on the of cost of the five previously defined items. The alignment alternative with the least cost was given the highest rating. The SEIS was rated a 4, the Adjusted SEIS a 2, the Elevated a 1.5, and the Split a 1.

Geometrics/Safety The alignment alternatives were rated for their geometrics/safety. Those alternatives that had an increased driver expectation and termed safer were given a higher rating. There are several design parameters that affect the geometrics/safety of the highway. A partial listing of those items are: degree of curve, vertical profile, superelevations, clear zone. The SEIS rated a 5 due to the low number of curves and a relatively flat, constant grade. The Adjusted SEIS was rated a 4.5 due the low number of curves and relatively flat grade. The Elevated was rated a 4 due to the vertical profile and grades in trying to raise the roadway to reduce the cut slope heights. The Split rated a 3 due to the construction of a natural rock median cut slope and retaining walls, and the grades required to achieve the vertical separation between the up and down canyon traffic lanes.

Geotechnical/Maintenance Geotechnical and maintenance issues are an important part of this project. Those alternatives that required increased maintenance or were geotechnically unstable, and required additional stabilization measures were rated lower. The SEIS alternative and associated cut slopes as outlined in the document could not be constructed without additional stabilization measures. As a result the SEIS alignment was rated a 1. The Adjusted SEIS, modeled with the correct cut slopes was rated a 3. The Elevated alternative was rated a 4 because it raised grade to reduce the cut slope heights. The Split was rated a 2 due to a natural median rock cut slope and median retaining walls.

Environmental It was found that portions of the SEIS alignment and retaining walls would need to be constructed in the river. This was considered unacceptable, therefore it was rated a 0. The Adjusted SEIS, Elevated, and Split were all rated a 4 due to similar impacts. The alignment alternatives were shifted "hillside" to avoid the river, but resulted in increased cut slope heights, and some additional retaining walls.

Constructability Modeling the SEIS alignment resulted in portions of the alignment and retaining walls having to be constructed in the river. This would make construction difficult and mitigation necessary. and resulted in a rating of 2. The Adjusted SEIS rated a 5 because the new roadway was out of the river and half of the new roadway could be built while keeping traffic on the existing highway.. The Elevated alignment was rated a 1 due to difficulty in building the MSE retaining walls and still being able to maintain traffic. Traffic would need to be shifted back and forth many times as the retaining walls increased in height toward final grade. The Split alignment rated a 4 due to construction of a median rock cut slope and retaining walls.

Traffic Control The SEIS alignment was rated a 2.5 because the final roadway grade was similar to the current roadway grade. This would facilitate the shifting of traffic back and forth while constructing half of the new roadway. The lower rating was the result of having to construct retaining walls in the river. The Adjusted SEIS alternative was rated a 3 for the same reasons as the SEIS, with the exception that there would be no retaining walls. The Elevated alternative was rated a 1 since it would entail the most difficult traffic control due to the constant need to switch traffic back and forth while constructing the MSE walls to finished grade. The Split rated a 3 due to the need to construct median retaining and cut side tie-back walls while trying to maintain traffic on the existing highway.

Public Comment Public comment received at the April 27 and 28, 1994 Public Workshops centered around staying out of the river. The SEIS alternative does not do this and therefore was rated a 1. Both the Adjusted SEIS and the Elevated were rated a 3 because they were away from the river but traded added cut slope heights and river side retaining walls. The Split rated a 4 because the public perceived both directions of traffic having better views of the river, and they liked the lanes separated for safety reasons.

<u>Section 2 Discussion</u>

The VE Team discussed the alignment alternatives and determined that further evaluation of Section 2 was necessary. The biggest concerns were:

1. Placing tie-back walls where movement may occur
2. UDOT Structures Division would prefer a single span structure which is on a tangent section. The cost of the structures may be reduced by meeting these requirements.
3. Not enough geotechnical information on the Hoover Slide was available to make a good decision on the recommended alignment. Based on the slide information, some of the alternatives may not be constructable.

The VE Team felt they should step back into the **speculation** phase and see if there were any feasible alternatives that had not been previously considered. The VE Team set September 28, 1994 as the date to reassemble and evaluate the additional alignment alternatives. Centennial Engineering presented another in depth study of alignment alternatives titled <u>Additional Alignment Alternatives and Issues</u>. This document, in conjunction with <u>Provo Canyon U.S. 189 Wildwood to Deer Creek State</u>

Park, Value Engineering Evaluation Information Summary will be included in the final draft of the Provo Canyon U.S. 189 Wildwood to Deer Creek State Park, Alignment Summary Report.'

Section 3 Discussion

Cost The alignment alternatives were rated solely on the cost of the five previously defined items. The alignment alternative with the least cost was given the highest rating. The SEIS was rated a 3 due to cost of an expensive bridge structure and a snow shed. The Buttress Fill alternative was the least costly and was rated a 5. The alignment avoided the first avalanche path and as a result there was no need for a bridge. The two bridges required to avoid the second avalanche path in the SEIS and Split options were replaced with a snow shed. The Buttress Fill provides a excavation cost savings by having a material waste site located within the project limits. The Split was rated a 3 due to the cost of three bridges and median retaining walls.

Geometrics/Safety The alignment alternatives were rated for their geometrics/safety. Those alternatives that had an increased driver expectation and termed safer were given a higher rating. The SEIS alignment had a low number of curves and a relatively flat grade but was rated a 3 due to the potential snow and ice problems on the two bridge structures. Buttress Fill has steeper grades and more curves but would reduce the potential snow and ice problems and was rated a 4. The Split alignment was rated a 2.5 due to the construction of a natural rock median cut slope and retaining walls, and the grades required to achieve the vertical separation between the up and down canyon traffic lanes. Potential snow and ice problems on the three bridge structures contributed to the low rating.

Geotechnical/Maintenance There does not appear to be any slide stability problems with any of the alternatives in this section, and the maintenance appears to be similar for all alignments. The same consideration was given to alignments having MSE retaining walls or structures. The SEIS, Buttress Fill, and Split alignments were all rated a 3. All three alternatives make provisions for the two avalanche paths near the dam.

Environmental The Weeks Bench Archeological Site is a prehistoric property and is eligible for the National Register of Historic Places (NRHP). Adverse impacts to the site can be mitigated through appropriate research. The SEIS alignment would affect the NRHP site but would be mitigated with no adverse impacts. This alignment would not directly impact any stream habitat and was rated a 3. The Buttress Fill alignment would not affect the NRHP site but would affect stream habitat along the existing Deer Creek Reservoir outlet and Little Deer Creek and was rated a 3. The Split alignment would affect the NRHP site but would be mitigated with no adverse impacts. This alignment would not directly impact any stream habitat and allows for reduced cut heights and was rated a 3.5.

Constructability Structures, either retaining wall or bridges, are required for all three alternatives. There was no consensus on which structures would be the most difficult to construct. The SEIS alignment was rated a 0 due to the finished road grade elevation being below the crest of the dam which could affect the integrity of the dam and was deemed not constructable. The Buttress Fill alignment was rated a 3 due to the difficult excavation of the cut slopes on the south side of the reservoir since it would be necessary to retain rockfall from entering traffic lanes while blasting. The lower rating was also due to the scheduling problems created by the hauling of fill material throughout the job. The Split alignment was rated a 3.5 due to the difficult excavation of the cut slopes on the south side of the reservoir. It would be necessary to retain rockfall from entering traffic lanes while blasting but the split roadway configuration would allow the construction of one set of traffic lanes at a time.

Traffic Control The SEIS alignment was rated a 1 because the final roadway grade requires use of the current roadway grade to construct bridge structures making traffic control very difficult. The Buttress Fill was rated a 3 due to the ability to maintain traffic on the existing roadway while constructing the fill section. The lower rating was also due to the traffic control problems created by hauling fill material throughout the job. The Split alignment was rated a 3.5 due to the split roadway allowing for the shifting of traffic back and forth while constructing half of the new roadway.

Public Comment The SEIS was rated a 1 due to the finished roadway elevation being below the crest elevation of the dam and the long bridge structures potentially having ice and snow problems. The idea for the Buttress Fill alignment came from public comment. The alignment avoided the long bridge structures and provided a waste disposal site on the project and was rated a 3. The Split alignment received positive public comment due to reduced impacts with the split roadway configuration and improved traffic control during construction. The alignment was rated a 2 due to the potential snow and ice problems on the three bridge structures.

Section 4 Discussion

The original SEIS alternative was the best option, and our brainstorming efforts did not result in any new or better ideas.

Cost The SEIS was rated a 4. There were no bridge structures or retaining walls and this was the only option advanced.

Geometrics/Safety The SEIS was rated a 3. The SEIS alternative follows the existing highway both horizontally and vertical and is mostly tangent sections. There is sufficient width to achieve clear zone.

Geotechnical/Maintenance The SEIS was rated a 4. This section presents no unusual geology requiring expensive engineering fixes. There are no steep rock cuts, and only shallow fills.

Environmental The SEIS was rated a 4. There are no new disturbances because the new roadway is within UDOT existing Right of Way. Section 4 is critical big game winter range. Fencing will be necessary to limit big game vehicle conflicts.

Constructability The SEIS was rated a 5. Because the new highway approximates the existing highway horizontally and vertically, construction of the new highway can be carried out while maintaining traffic on the existing roadway.

Traffic Control The SEIS was rated a 5. The close proximity of the new highway to old will facilitate the shifting of traffic back and forth while constructing half the new roadway.

Public Comment The SEIS was rated a 4. There was no adverse comments to this alternative as it follows the alignment from the document.

Meeting held August 31 and September 1, 1994 - Additional Advantages/Disadvantages Roadway Section 2

The VE team determined that additional information in Section 2 was necessary. The VE Team reentered the **evaluation** phase and 10 additional alignment alternatives were compared and the advantages and disadvantages are listed below.

Section 2 - Horseshoe Bend to the Heber Valley Historic Railroad Overpass

1. SEIS Alignment "A"

Advantages	Disadvantages
Out of the slide area Stays away from the river No bridges Easier traffic control	Difficult constructability *Differs from approved alignment in SEIS Document *New highway facility in untouched location Length of alignment 2 miles longer Roadway not a direct route *Increased user costs associated with increased length River access restricted Continuous 5% grades Time frame for design Canyon Meadows impact Loss of wildlife winter range Tie-back retaining walls needed

Idea will **not** be forwarded

2. Up Canyon (SEIS), Down Canyon (Upper Variation)

Advantages	Disadvantages
Eliminate some tie-back retaining walls One-half the bridge width needed Less cut heights, excavation, and impacts to Canyon Meadows due to one-half the typical section Alignments can double as detours for maintenance Better constructability Easier traffic control River access maintained	*Bridges and retaining walls located on slide *Very high cost Cross river twice *High bridge maintenance and rehabilitation costs Alignment crosses slide Toe walls needed *Tied arch bridge type (fracture critical) Extra bridge width needed to accommodate horizontal curvature with striping Removal of some homes Houses in median area Future highway maintenance and rehabilitation costs Canyon Meadows impact *Maximizing environmental impacts of SEIS and Upper Variation alignments Unknown geotechnical and ground water conditions in Canyon Meadows

Idea will **not** be forwarded

3. Lower Variation, Relocate Railroad

Advantages	Disadvantages
Railroad bridge narrower than highway bridge Reduced retaining wall heights Use existing roadway Small or no cut heights Less excavation	Railroad structure on slide High cost Tunnel through knob Retaining walls needed Increase fill on existing road in Horseshoe Bend Affect river access Impact Heber Creeper Conflict with Salt Lake City Metro Water District aqueduct Possible historical clearance conflicts

Idea will be forwarded

*Denotes fatal flaw and will not be considered further.

4. Lower Variation, Relocate River

Advantages	Disadvantages
Build a safer roadway facility Freedom for alignment location	*The SEIS Document foreboded any reach of the Provo River for relocation

Idea will **not** be forwarded

5. East Side of the Provo River

Advantages	Disadvantages
Small or no cut heights Less excavation Easier traffic control	*Significantly differs from conceptual alignment in SEIS Document Environmental impacts Abandon existing alignment New highway facility in untouched location Impact to Heber Creeper *Negative public sentiment associated with additional river crossings on past projects resulted in numerous redesign efforts River access restricted *Conflict with Salt Lake City Metro Water District aqueduct

Idea will **not** be forwarded

6. Up Canyon (Existing Alignment), Down Canyon (Upper Variation)

Advantages	Disadvantages
No bridges on slide Eliminate some tie-back retaining walls Stays out of the river Less cut heights, excavation, and impacts to Canyon Meadows due to one-half the typical section Alignments can double as detours for maintenance Tail lights only for Canyon Meadows Clean up cut slope Better constructability Easier traffic control	*Retaining walls located on slide High cost Unstable slope north of Horseshoe Bend Removal of some homes Houses in median area *Maximizing environmental impacts of existing and Upper Variation alignments Alignment crosses slide *Future highway maintenance and rehabilitation costs Canyon Meadows impact Unknown geotechnical and ground water conditions in Canyon Meadows Difficult geometrics for river access

Idea will **not** be forwarded

7a. Tangent Bridge

Advantages	Disadvantages
No retaining walls No Canyon Meadows impact Small or no cut heights Less excavation Less bridge length and width needed with tangent sections	Very high cost Bridge on slide Difficult design High bridge maintenance and rehabilitation costs High design costs Conflict with Salt Lake City Metro Water District aqueduct Environmental impacts to Pines Area

Idea will be forwarded

*Denotes fatal flaw and will not be considered further.

7b. Up Canyon (Tangent Bridge), Down Canyon (Upper Variation)

Advantages	Disadvantages
Less cut heights, excavation, and impacts to Canyon Meadows due to one-half the typical section Eliminate some tie-back retaining walls One-half the bridge width needed Alignments can double as detours for maintenance Better constructability Easier traffic control	*Very high cost Bridge on slide Difficult design High design costs *Conflict with Salt Lake City Metro Water District aqueduct *Maximizing environmental impacts of Tangent Bridge and Upper Variation alignments

Idea will **not** be forwarded

8. Up Canyon (Tangent Bridge), Down Canyon (Existing Alignment)

Advantages	Disadvantages
Avoid Canyon Meadows Eliminate some tie-back retaining walls One-half the bridge width needed Alignments can double as detours for maintenance Better constructability Easier traffic control Use existing roadway	Very high cost Bridge and retaining walls on slide Difficult design High design costs Conflict with Salt Lake City Metro Water District aqueduct Maximizing environmental impacts of Tangent Bridge and existing alignments

Idea will be forwarded

9. Enclose Railroad and Build Roadway Over Railroad

Advantages	Disadvantages
Reduced retaining wall heights Small or no cut heights Less excavation Disturbs less new area by utilizing the existing roadway prism	Rigid structure on slide High cost Structure over railroad is close to riparian area Increase fill on existing road in Horseshoe Bend Toe walls needed Possible adverse cultural effect

Idea will be forwarded

10. Upper Variation

Advantages	Disadvantages
No structures (bridge/wall) on slide Better fishing access Easier traffic control Lower cost Less cuts and excavation-easier to mitigate and revegetate Safer highway geometrics from saddle to dam Less geotechnical risk of losing retaining walls/structures No removal of homes	Large cut north of Horseshoe Bend Canyon Meadows impact Wetland impact Loss of wildlife winter range Steep grade from Horseshoe Bend to saddle Unknown geotechnical and ground water conditions in Canyon Meadows

Idea will be forwarded

*Denotes fatal flaw and will not be considered further.

Meeting held September 28, 1994 - Weighting and Criteria Roadway Section 2

Section 2 Discussion

Centennial Engineering presented the additional information. The VE Team discussed the weighting factors and determined that for consistency, the same weighting would be used for this meeting as was used in the previous meeting. As before, the weighting did not have an affect on the outcome of the scoring for the recommended alternative.

Cost The alignment alternatives were rated solely on the cost of the five previously defined items. The alignment alternative with the least cost was given the highest rating. The SEIS alignment was rated a 2 due to the cost of the two bridges at Horseshoe Bend. The Lower Variation alignment was rated a 1 due to the amount of retaining wall needed resulting in an increased cost. The Revised Upper Variation alignment was rated a 5 due to no bridges in Horseshoe Bend and the amount of retaining wall being reduced resulting in a significant cost savings. This alternative was the least expensive by almost $10 million. The Split Upper Variation alignment was rated a 0.5 due to excessive retaining wall costs. The Tangent Bridges alignment was rated a 2 due to the cost of two bridges at Horseshoe Bend. The Cantilever Section alignment was rated a 3 due to one structure required to support the roadway through Horseshoe Bend. The Split (Lower & Tangent Bridges) alignment was rated a 1. This alternative was a combination of the two alignments and the specific reasons for the rating are detailed above. All of these alignment options require some degree of stabilization. The more extensive the stabilization the more costly the alignment. Refer to the Geotechnical/Maintenance section for discussion.

Geometrics/Safety The alignment alternatives were rated for their geometrics/safety. Those alternatives that had an increased driver expectation and termed safer were given a higher rating. The SEIS alignment had a low number of curves and a relatively flat grade but was rated a 4 due to the potential snow and ice problems on the bridge structures. The Lower Variation alignment was rated a 3 because it had a steeper grade and tighter curves even though the ice and snow problems on the structures were avoided. The Revised Upper Variation alignment was rated a 4 due to a steeper grade but a low number of curves and the ice and snow problems on the structures were avoided. The Split Upper Variation was rated a 2 due to the construction of a natural rock median cut slope and retaining walls and the grades required to achieve the vertical separation between the up and down canyon traffic lanes. The Tangent Bridges alignment was rated a 2 due to the increase in the number of horizontal curves as well as the potential snow and ice problems on the bridge structures. To achieve tangent sections for the bridges, reverse curves were required at the entrance and exit of the bridges. The Cantilever Section alignment was rated a 2 due to the steeper grade, tighter curves, and the potential for snow and ice problems associated with an overhanging section of roadway. The roadway would be extended out over the Heber Creeper, and future plans for a steam locomotive introduced additional icing concerns. The Split (Lower & Tangent Bridges) alignment was rated a 2. This alternative was a combination of the two alignments, Lower Variation and Tangent Bridges, and the specific reasons for the rating are detailed above.

Geotechnical/Maintenance Geotechnical and maintenance issues are an important part of this project. Those alternatives that required increased maintenance or were geotechnically unstable, and required additional stabilization measures were rated lower. The SEIS was rated a 1 due to the stabilization measures that would be necessary to stabilize the existing landslide and mitigate movement in the bridges that would cross Horseshoe Bend. The Lower Variation was rated a 2 due to the stabilization measures that would be necessary to stabilize the existing landslide. The Revised Upper Variation alignment would require the least amount of stabilization of the existing landslide and avoided the two bridges and was, therefore, rated a 4. The Split Upper Variation alignment was rated a 2 due to the need for median and tie-back retaining walls. Less stabilization of the existing landslide is needed as compared to the SEIS. The Tangent Bridges alignment was rated a 1.5 due to the stabilization measures of the existing landslide and the mitigation of movement in the bridges that would cross Horseshoe Bend. The Cantilever Section alignment was rated a 1 due to the cantilever section being a rigid structure in an area of continual movement. The stabilization measures would be very expensive, and the maintenance and repair of the structure would be very difficult. The Split (Lower & Tangent Bridges) alignment was rated a 1. This alignment was a combination of the two alignments, and the specific reasons for the rating are detailed above.

Environmental The SEIS alignment affected the wetlands near the Provo River and was rated a 2. The Lower Variation alignment followed the existing roadway without impacting new territory or the river and was rated a 4. The Revised Upper Variation had no impact to the river and would not adversely affect the wildlife and was rated a 3. The lower rating was due to the impacts to the Canyon Meadows area. The Split Upper Variation had no impact to the river and would not adversely affect the wildlife, but this alignment would impact a greater area and was rated a 2.5. The Tangent Bridges alignment places bridge abutments close to the Provo River negatively impacting the river and was rated a 2. The Cantilever Section alignment followed the existing roadway without impacting new territory or the river and was rated a 4. The Split (Lower & Tangent Bridges) alignment combined the negative impacts of both the Lower Variation and Tangent Bridges alignments and was rated a 2. The specific reasons for the rating are detailed above.

Constructability Those alignments that resulted in difficult construction were rated lower. Difficult construction would result from the construction of bridge abutments, cantilever section, or retaining walls on the Hoover Slide. The SEIS alignment would require the construction of two bridges and their abutments and was rated a 2. The Lower Variation alignment would require extensive MSE retaining walls to be built around Horseshoe Bend to prevent railroad and river encroachment and was rated a 2. The Revised Upper Variation alignment would require some wall construction and was rated a 4. The Split Upper Variation alignment would require some wall construction and construction of a median rock cut slope, therefore, the alignment was rated a 3. The Tangent Bridges alignment would require the construction of two bridges and their abutments and was rated a 2. The Cantilever Section alignment would have difficulty during construction due to the rigid cantilever section as well as requiring the temporary removal and rebuilding of the railroad. It was rated a 2. The Split (Lower & Tangent Bridges) alignment combined the difficult constructability aspects of both the Lower Variation and Tangent Bridges alignments and was rated a 2. The specific reasons for the rating are detailed above.

Traffic Control Alternatives that could be constructed off or away from the current roadway grade while maintaining traffic were rated higher. Those alternatives that require the construction of both the new highway and structures on or near the existing highway making traffic control difficult were rated lower. The SEIS alignment was rated a 2 due to the final roadway being similar to the current roadway grade. This would facilitate the shifting of traffic back and forth while constructing half of the new roadway. The lower rating was the result of the construction of walls and bridge abutments. The Lower Variation alignment was rated a 1 due to the finished roadway being constructed above the current roadway grade and the construction of MSE retaining walls at Horseshoe Bend. The Revised Upper Variation and the Split Upper Variation alignments were both rated a 4 because a large portion of the alignment could be constructed away from the current roadway while maintaining traffic The amount of retaining wall construction would be less than the SEIS alignment. The Tangent Bridges alignment was rated a 2 due to most of the finished roadway being constructed above the current roadway making traffic control difficult for the construction of bridges and abutments. The Cantilever Section alignment was rated a 2 due to the finished roadway being constructed above the current roadway making traffic control difficult for the construction of the cantilever at Horseshoe Bend. The Split (Lower & Tangent Bridges) alignment was rated a 3 due to the ability to use the current roadway grade while the Tangent Bridges would be constructed and then detour to the Tangent Bridges alignment while the Lower Variation alignment would be completed..

Public Comment Public comment received at the April 27 and 28, 1994 Public Workshops were split between staying out of the river and avoiding Canyon Meadows. An alternative was rated on how it affected these two areas. The SEIS alignment was an approved alignment and was rated a 3 due to the fact that it is close to the river and crosses twice but stays away from the Canyon Meadows area. The Lower Variation alignment stays away from the river and Canyon Meadows and was rated a 5. The Revised Upper Variation and the Split Upper Variation alignments both stay away from the river but are not popular with the residents of Canyon Meadows, therefore, they were both rated a 2. The Tangent Bridges alignment is close to the river but stays away from Canyon Meadows and was rated a 2. The Cantilever Section alignment stays away from the river and Canyon Meadows and was rated a 5. The Split (Lower & Tangent Bridges) alignment is close to the river and crosses twice but with a narrower bridge than the SEIS alignment. The alignment stays away from Canyon Meadows and was rated a 3.

Summary

Raw Scores								
Alternative	Cost	Geometrics/ Safety	Geotechnical/ Maintenance	Environmental	Constructability	Traffic Control	Public Comment	Total
Section 1								
SEIS	4	5	1	0	2	2.5	1	15.5
Adj SEIS	2	4.5	3	4	5	3	3	24.5
Elevated	1.5	4	4	4	1	1	3	18.5
Split	1	3	2	4	4	3	4	21
Section 2								
SEIS	2	4	1	2	2	2	3	16
Lower	1	3	2	4	2	1	5	18
Upper	5	4	4	3	4	4	2	26
Split Upper	0.5	2	2	2.5	3	4	2	16
Tangent	2	2	1.5	2	2	2	2	13.5
Cantilever	3	2	1	4	2	2	5	19
Split Lower	1	2	1	2	2	3	3	14
Section 3								
SEIS	3	3	3	3	0	1	1	14
Buttress	5	4	3	3	3	3	3	24
Split	3	2.5	3	3.5	3.5	3.5	2	21
Section 4								
SEIS	4	3	4	4	5	5	4	29

In the VE Team meetings on August 31, September 1, and September 28, 1994, a Recommended Alignment for each section was selected:

Section 1	Adjusted SEIS Alignment
Section 2	Revised Upper Variation
Section 3	Buttress Fill Alignment
Section 4	SEIS Alignment

The benchmark to compare the results of this study was the original SEIS alignment. The results given here will compare the cost of the SEIS alignment with the selected Recommended Alignment. For specifics concerning differences between the SEIS and the Recommended Alignments, please refer to the Provo Canyon, U.S. 189, Wildwood to Deer Creek State Park, Alignment Summary Report.

Cost Savings

Section 1

The Recommended Alignment is the Adjusted SEIS Alignment. The cost of the Adjusted SEIS is $4,944,806. This cost can not be compared with the SEIS Alignment because the SEIS Alignment was determined not constructable. No savings were realized.

Section 2

The Recommended Alignment is the Revised Upper Variation Alignment. The cost of the Revised Upper Variation Alignment is $15,719,053. The cost of the SEIS Alignment is $21,359,226. The Recommended Alignment results in a savings of $5,640,173.

Section 3

The Recommended Alignment is the Buttress Fill Alignment. The cost of the Buttress Fill Alignment is $13,662,998. This cost differs from that shown in the Value Engineering Evaluation Information Summary. The difference is that the borrow item was eliminated by the available excess from the rest of the project. The cost of the SEIS Alignment is $23,651,170. The Recommended Alignment results in a savings of $9,988,172.

Section 4

The Recommended Alignment is the SEIS Alignment. The cost of the SEIS Alignment is $2,923,302. There were no savings realized.

Total Savings (Sections 1-4)	$15,628,345
Total Cost of VE Study	48,591